In the Claims

This listing of claims replaces all prior versions.

1. (Currently Amended) A method for manufacturing a semiconductor device using a <u>first</u> material that is substantially unreactive with the liquid-phase material, the method comprising:

epitaxially growing a single-crystalline <u>structure</u> [material] from a liquid-phase material while using the <u>first</u> material having a physical orientation that directs the growth of the single-crystalline <u>structure</u> [material] to mitigate defects in the epitaxially grown crystalline structure.

2. (Original) The method of claim 1, wherein the physical orientation of the unreactive material includes a passageway with a cross-sectional area that is sufficiently small to mitigate crystalline growth defects as a crystalline growth front of the liquid-phase material passes through the passageway.

3. (Currently Amended) The method of claim 1, wherein the physical orientation of the unreactive material necks the directed growth of the single-crystalline <u>structure</u> [material].

4. (Original) The method of claim 1, wherein the physical orientation of the unreactive material is adapted to cause a crystalline growth front of the liquid-phase material to change direction.

5. (Original) The method of claim 1, further comprising:

forming a layer of the unreactive material on a substrate amenable to seeding crystalline growth of the liquid-phase material;

removing a portion of the unreactive material to expose a seed location on the substrate;

forming a solid-phase form of the liquid-phase material on the exposed substrate;

substantially enclosing the solid-phase form of the liquid phase material with the unreactive material and liquefying the solid-phase form of the liquid-phase material; and

initiating crystalline growth at the seed location.

6. (Currently Amended) The method of claim 5, wherein forming a layer of the unreactive material includes forming a layer of insulative material, and further including growing single-crystalline <u>structure</u> [material] on the insulative material.

7. (Original) The method of claim 5, wherein forming a solid-phase form of the liquid-phase material includes forming the solid-phase form of the liquid-phase material on the substantially unreactive material.

8. (Original) The method of claim 7, wherein the physical orientation of the material is used to mitigate defects due to a lattice mismatch between the liquid-phase material and another material immediately adjacent the liquid-phase material.

9. (Original) The method of claim 1, further comprising:

forming a solid-phase material in contact with a seeding substrate;

patterning the solid-phase material to form the physical orientation;

liquefying the solid-phase material to form the liquid-phase material while substantially containing the liquid-phase material with the unreactive material; and

initiating crystalline growth at an interface between the liquid-phase material and the seeding substrate.

10. (Original) The method of claim 9, wherein initiating crystalline growth comprises:

growing crystalline structure immediately adjacent the interface and permitting formation of lattice mismatch defects as a function of a crystalline lattice mismatch between the seeding substrate and the liquid-phase material; and

using the substantially unreactive material to mitigate the lattice mismatch defects and continuing to grow crystalline structure that is substantially free of the lattice mismatch defects.

11. (Currently Amended) A system for manufacturing a semiconductor device, the system comprising:

means for containing a liquid-phase material without reacting to the liquid-phase material; and

means for mitigating crystalline structure defects while epitaxially growing a substantially single-crystalline structure [material] from the liquid-phase material.

12. (Currently Amended) A system for manufacturing a semiconductor device, the system comprising:

a crucible configured and arranged to contain a liquid-phase material, the crucible being substantially unreactive with the liquid-phase material; and

a portion of the crucible configured and arranged to mitigate crystalline structure defects while epitaxially growing a crystalline structure including substantially single-crystalline structure [material] from the liquid-phase material.

13. (Original) A single-crystalline growth device comprising:

a seeding material; and

a containing structure configured and arranged to contain a liquid-phase material, the containing structure being substantially unreactive with the liquid-phase material and, upon crystallization of the liquid-phase material, configured and arranged to mitigate the formation of crystalline defects in the crystallizing liquid-phase material and thereby promote single-crystalline growth.

14. (Original) A method for manufacturing a semiconductor device, the method comprising:

introducing a liquid-phase material including germanium to an inert-type material; and

epitaxially growing a crystalline structure including single-crystal germanium from the liquid-phase material over the inert-type material and forming a germanium-on-insulator (GeOI) structure including the crystalline structure and the inert-type material.

15. (Original) The method of claim 14, wherein growing a crystalline structure including germanium includes growing epitaxial crystalline germanium with negligible random nucleation growth of germanium.

16. (Original) The method of claim 14, wherein introducing a liquid-phase material including germanium to an inert-type material includes introducing the liquid-phase material to a silicon seed location and wherein epitaxially growing a crystalline structure including germanium includes growing the crystalline germanium from the silicon seed location.

17. (Original) The method of claim 16, wherein growing the crystalline germanium from the silicon seed location includes growing the crystalline germanium with lattice-mismatch defects near the silicon seed location in a first direction and subsequently growing the crystalline germanium via epitaxial growth in a second direction away from the silicon substrate, the epitaxial growth in the second direction forming single-crystal germanium with lattice mismatch defects therein being mitigated by a shape of the inert-type material.

18. (Original) The method of claim 16, further comprising:

forming a layer of the inert-type material on a silicon substrate;

patterning an opening in the inert-type material and exposing the silicon substrate to form the silicon seed location; and

wherein growing the crystalline germanium from the silicon seed location includes growing crystalline germanium in a first direction upward from the silicon seed location and growing single-crystalline germanium over the inert-type material and in a lateral direction from the silicon seed location.

19. (Original) The method of claim 18, wherein patterning an opening in the inert-type material includes patterning an opening having a sufficient height-to-width ratio that causes a necking effect in the crystallization of germanium crystal structure growing upward from the silicon seed location, the necking effect causing lattice-mismatch defects to terminate upon the crystalline structure growth extending in the lateral direction.

20. (Original) The method of claim 14, further comprising:

forming germanium-containing material over the inert-type material;

forming another inert-type material over and enclosing at least a portion of the germanium-containing material; and

wherein introducing a liquid-phase material including germanium to an inert-type material includes heating and liquefying the germanium-containing material while using the inert-type material to hold the liquid-phase material in place.

21. (Original) The method of claim 20, wherein forming a GeOI structure includes forming the GeOI structure over a silicon-based substrate and adjacent to a silicon-based structure region employing a portion of the silicon-based substrate as an active region.

22. (Original) The method of claim 21, wherein forming germanium-containing material over the inert-type material and forming another inert-type material over and enclosing at least a portion of the germanium-containing material includes forming and enclosing germanium-containing material adjacent to the silicon-based structure and using the inert-type material to inhibit the liquid-phase germanium from flowing to the silicon-based structure.

23. (Original) A method for manufacturing a semiconductor device including an inert-type material layer over a substrate, the method comprising:

patterning an opening in the inert-type material to expose a portion of the substrate and form a seed location for crystallizing germanium at a bottom portion of the opening at the exposed substrate;

forming germanium-based material in the opening and over the inert-type material;

forming another inert-type material over the germanium-based material;

using the inert-type material to contain the germanium-based material, heating the germanium-based material and forming a liquid; and

cooling and crystallizing the germanium-based material, the crystallizing beginning at the seed location and crystallizing the liquid germanium in a direction toward the inert-type material over the germanium-based material and using the inert-type material to cause a change in growth direction of the crystallization, such that the change in growth direction inhibits subsequent formation of crystalline defects and promotes subsequent crystallization of the liquid germanium into single-crystal germanium.

24. (Original) The method of claim 23, wherein cooling and crystallizing the germanium-based material includes forming a germanium-based material that is substantially single-crystal germanium.

25. (Original) The method of claim 23, wherein cooling and crystallizing the germanium-based material includes forming an interface between the germanium-based material and the inert-type material that is substantially free of defects associated with a lattice mismatch between the germanium and the exposed substrate.

26. (Original) The method of claim 23, wherein cooling and crystallizing the germanium-based material includes forming an interface between the germanium-based material and the inert-type material that is substantially single-crystal germanium.

27. (Original) The method of claim 23, wherein patterning an opening in the inert-type material includes patterning an opening having a height to width aspect ratio selected as a function of an expected crystalline growth front direction of the germanium.

28. (Original) The method of claim 23, wherein patterning an opening in the inert-type material includes patterning an opening having a height to width aspect ratio sufficiently high to cause a change in direction during crystallization of the germanium-based material over the opening to inhibit crystalline defect growth to an area that is substantially over the opening.

29. (Original) The method of claim 23, wherein:

patterning an opening in the inert-type material includes patterning an opening extending from an upper surface of the inert-type material and down through the inert-type material to the substrate; and

cooling and crystallizing the germanium-based material includes crystallizing the germanium-based material with a growth front propagating in a first direction away from a lower portion of the opening where the germanium is adjacent the exposed substrate and subsequently crystallizing the germanium-based material with a growth front propagating in a second generally lateral direction.

30. (Original) The method of claim 29, wherein crystallizing the germanium-based material in a first direction includes forming a crystalline structure having defects and wherein subsequently crystallizing the germanium-based material in a second generally lateral direction includes forming substantially single-crystal germanium.

31. (Original) The method of claim 30, wherein crystallizing the germanium-based material in a second generally lateral direction includes mitigating the formation of crystalline defects with the change in direction of the crystallization growth front.

32. (Original) The method of claim 31 wherein mitigating the formation of crystalline defects includes using a top portion of the inert material over the seed location to mitigate crystalline defects.

33. (Original) The method of claim 31, wherein mitigating the formation of crystalline defects includes using a sidewall of the patterned opening in the inert-type material to mitigate crystalline defects

34. (Original) The method of claim 29, wherein crystallizing the germanium-based material in a second generally lateral direction includes growing crystallized germanium via epitaxial growth.

35. (Original) The method of claim 29, wherein crystallizing the germanium-based material in a second generally lateral direction includes mitigating random nucleation growth of germanium.

36. (Original) The method of claim 23, further comprising forming a thin silicon layer between the substrate and the inert-type material, wherein forming germanium-based material over the inert-type material includes forming germanium-based material on the thin silicon layer.

37. (Original) The method of claim 23, wherein forming germanium-based material in the opening and over the inert-type material includes forming a layer of germanium-based material in the opening and over the inert-type material and subsequently patterning the germanium-based layer to form a patterned portion thereof in the opening and over the inert-type material.

38. (Original) The method of claim 23, wherein:

patterning an opening in the inert-type material includes patterning a plurality of openings in the inert-type material;

forming germanium-based material in the opening and over the inert-type material includes patterning distinct locations of germanium-based material in the plurality of openings and over the inert-type material immediately adjacent the openings; and

forming an inert-type material over the germanium-based material includes forming inert-type material to separately contain each of the distinct locations of germanium-based material.

39. (Original) A system for manufacturing a semiconductor device, the system comprising:

means for introducing a liquid-phase material including germanium to an inert-type material; and

means for epitaxially growing a crystalline structure, including single-crystal germanium, from the liquid-phase material over the inert-type material and for forming a germanium-on-insulator (GeOI) structure including the crystalline structure and the inert-type material.

40. (Original) A system for manufacturing a semiconductor device, the system comprising:

a heating arrangement for introducing a liquid-phase material including germanium to an inert-type material; and

a containment arrangement for facilitating epitaxial growth of a crystalline structure including single-crystal germanium from the liquid-phase material over the inert-type material and for forming a germanium-on-insulator (GeOI) structure including the crystalline structure and the inert-type material.

41. (Original) A single-crystalline germanium growth device comprising:

a substrate;

an inert-type layer over a portion of the substrate immediately adjacent an exposed portion of the substrate; and

another inert-type material over the inert-type layer and exposed portion of the substrate and configured and arranged, with the substrate and the inert-type layer, to contain a liquid-phase germanium material and, upon cooling of the liquid-phase germanium material, to cause a change in direction of a crystalline growth front of the germanium and thereby promote single-crystal germanium growth.

42. (New) A semiconductor device comprising:

a seeding location;

a single-crystalline structure having a portion extending from the seeding location toward a passageway with a cross-sectional area that is sufficiently small to mitigate crystalline growth defects in the portion extending from the seeding location.

43. (New) The device of claim 42, wherein the single-crystalline structure is part of a Germanium-on-insulator structure.

44. (New) The device of claim 42, wherein part of the single-crystalline structure includes one of a diode, an LED and a transistor.

45. (New) The device of claim 42, wherein the seeding location includes silicon.

46. (New) A semiconductor device in an intermediate manufacturing stage, the device comprising:

a seeding location;

an insulator layer; and

a single-crystalline structure having a portion extending over the insulator layer and a portion extending from the seeding location toward a passageway with a cross-

sectional area that is sufficiently small to mitigate crystalline growth defects in the portion extending from the seeding location.

47. (New) The device of claim 46, wherein the seeding location is located at a silicon substrate.

48. (New) An optical semiconductor device, the device comprising:

a seeding location;

a seeding location;

an insulator layer; and

an active portion that has a single-crystalline layer extending over the insulator layer and that has a first portion that includes a strained material that communicates light and a second portion extending from the seeding location toward a passageway with a cross-sectional area that is sufficiently small to mitigate crystalline growth defects in the second portion.

49. (New) The device of claim 48, wherein the strained material detects light.

50. (New) The device of claim 48, wherein the strained material emits light.

51. (New) The device of claim 48, wherein the first portion includes Germanium.

52. (New) The device of claim 48, wherein the strained material includes Germanium arranged on a virtual substrate.